

Appl. No. 10/650,601
Amdt. dated 12/02/2005
Reply to Office Action of 10/04/2005

Attorney Docket No.: TS01-999
12 N1085-90151

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REMARKS/ARGUMENTS

Claims 1-20 were previously pending in this application with claims 19 and 20 withdrawn from consideration and claims 12-18 allowed. In the present Office Action, claims 1-11 were rejected. Claims 1-4 and 9 are hereby amended. Applicants respectfully request re-examination and reconsideration of claims 1-11 and allowance of each of presently pending claims 1-18.

I. Allowable Subject Matter

Applicants thank the Examiner for indicating, in paragraph 8 of the Office Action, that claims 12-18 are allowed.

10 II. Rejection of Claim 3 under 35 U.S.C. § 112

In paragraph 3 of the Office Action, claim 3 was rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. Applicants respectfully submit that this claim rejection is overcome for reasons set forth below.

15 Claim 3 depends from claim 2 and was rejected due to an inconsistency between claims 2 and 3. Responsive to the rejection of claim 3, claim 2 has been amended to make it clear which silicon dioxide liner claim 3 refers to. Claim 3 has been amended for editorial purposes, as well.

As such, claims 2 and 3 now comply with the requirements of 35 U.S.C. § 112, second paragraph, and the rejection of claim 3 under 35 U.S.C. § 112, second paragraph, should therefore be withdrawn.

20 III. Rejection of Claims 1-3, 6, 9 and 11 under 35 U.S.C. § 103

In paragraph 5 of the Office Action, claims 1-3, 6, 9 and 11 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Chen, et al. (U.S. Pat. No. 5,110,755), hereinafter "Chen '755", in view of Lin, et al. (U.S. Pat. No. 6,436,791 B1), hereinafter "Lin '791". Applicants respectfully submit that these claim rejections are overcome for reasons set forth below.

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Independent claim 1 has been amended to more explicitly point out that which was inherently present in previously pending claim 1. Amended independent claim 1 recites the features of:

forming a trench on a semiconductor substrate; and

5 forming a dielectric layer on the surfaces of said trench; and

forming a heavily doped p⁺ layer surrounding said trench
after said forming a dielectric layer on the surfaces of said
trench.

Applicants first point out that amended claim 1 more clearly recites the "heavily
10 doped p⁺ layer surrounding said trench", said trench referring back to the antecedent
trench initially formed: "forming a trench in a semiconductor substrate". It is clearly
recited that the p⁺ buried layer SURROUNDS the originally formed trench. The p⁺ layer
of Chen '755 cannot and does not *surround* the originally formed trench because the p⁺
layer is formed inside of the originally formed trench as shown in FIG. 1B which shows
15 original trench 15 with surface 16, and FIG. 1C, which clearly shows the p⁺ layer formed
inside the trench, not surrounding it. Referring to FIGS. 1B and 1C, Chen '755 recites in
column 4, lines 47-50 "when the boron diffusion doping is carried out at the
aforementioned parameters, a doped layer 19 and 21 of material is formed over the
surface 16 of recess 15", emphasis added. Therefore, irrespective of the Examiners
20 adapted interpretation of "around", with respect to figure 3 of applicant's disclosure.
Chen does not teach the claimed feature of the heavily doped p⁺ layer surrounding the
original trench. Amended independent claim 1 is therefore distinguished from Chen
'755.

Amended independent claim 1 also recites the feature that the heavily doped
25 buried p⁺ layer is formed after the dielectric layer is formed on the surfaces of the
trench. Chen '755 cannot and does not teach this feature because, as acknowledged
by the Examiner, "Chen et al fails to teach the steps of forming a dielectric layer on the
surfaces of the trench pattern", subject Office action, page 3, lines 9-10.

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The Examiner then proffers Lin '791 for providing a vertical oxide layer 130 in a trench. Lin '791 does not disclose or suggest forming a heavily doped buried p⁺ layer surrounding the trench after forming the dielectric layer and therefore does not make up for the above-stated deficiencies of Chen '755. Claim 1 is therefore distinguished from
5 the references of Chen '755 and Lin '791 taken alone or in combination.

Moreover, claim 1 is not obvious, under the guidelines of 35 U.S.C. §103, with respect to Chen '755 in view of Lin '791 because, if one of ordinary skill and the art combined the teachings of these references, the claimed invention would not result. In fact, Applicants respectfully submit that the primary reference of Chen '755 teaches
10 away from forming an oxide liner on the sidewalls of the trench and then subsequently forming a p⁺ layer surrounding the trench. An examination of the process sequence shown in FIG. 1B and FIG. 1C of Chen '755, shows that doped layer 19 is only formed in areas deficient of silicon dioxide layer 7. This is because the silicon dioxide layer 7 is used as a mask to prevent the formation of the doped layer: "The silicon dioxide
15 advantageously provides an oxide mask that confines the deposition of impurity atoms to the walls and floor of the recess on the front side of the substrate" Chen '755 col. 3, lines 3-6. If one added the oxide liner 130 of Lin '791 to the opening (recess 15) of Chen '755, one could not subsequently form the doped layer 19 of Chen '755 according to the teachings of the Chen '755 and Lin '791 references; rather, oxide liner 130 would
20 serve as a mask that prevents formation of the doped layer therethrough. The oxide mask – silicon dioxide layer 7, of Chen '755 has a thickness of 3,000 angstroms in the preferred embodiment and the oxide layer from which the oxide spacer 130 is formed in Lin '791, includes a thickness of 2,000-3,500 angstroms and it does not appear that, nor is it suggested or illustrated, that the thickness of the oxide layer is diminished in
25 forming spacers 130 in Lin '791. Therefore, it is believed that the oxide layer of Lin '791 would form a suitable "mask" if used according to the Chen '755 teaching and therefore, if used in the Chen '755 process, this mask would prevent the formation of a heavily doped p⁺ layer surrounding the trench, after formation of Lin '791's oxide layer. Claim 1 is therefore further distinguished from the references

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Applicants respectfully submit that amended independent claim 1 is therefore distinguished from the references of Chen '755 and Lin '791, taken alone or in combination. The rejection of claim 1 under 35 U.S.C. § 103(a) should therefore be withdrawn. Claims 2, 3, 6, 9 and 11 depend directly from independent claim 1, with claim 9 amended for editorial purposes. Due to their dependency from distinguished claim 1, claims 2, 3, 6, 9 and 11 are also distinguished from the references of Chen '755 and Lin '791 and the rejection of these claims under 35 U.S.C. 103(a), should also be withdrawn.

IV. Rejection of Claims 4-5, 8 and 10 under 35 U.S.C. § 103

In paragraph 6 of the Office Action, claims 4-5, 8 and 10 were rejected under 35 U.S.C. § 103(a) as being unpatentable over "Chen, et al. (US Pat. No. 5,130,268)", hereinafter "USPN 5,130,268" in view of Lin '791 (as above) and further in view of Lin, et al. (U.S. Pat. No. 5,950,094), hereinafter "Lin '094". Applicants respectfully submit that these claim rejections are overcome for reasons set forth below.

As a first matter, Applicants are unsure as to whether the Examiner is referring to Chen '755, as defined above, or USPN 5,130,268 when referring to "Chen et al (U.S. Pat. No. 5,130,268)." USPN 5,130,268 does not appear in the PTO-892 form accompanying the subject or previous Office action. Moreover, USPN 5,130,268 lists Fu-Tai Liou as the first listed inventor. Also, in paragraph 5, the Examiner lists "Chen et al (U.S. Pat. No. 5,110,755)" and subsequently refers back to this reference as "Chen et al". Throughout paragraph 6, the Examiner also refers back to "Chen et al.", suggesting reference to the previously described "Chen et al." of paragraph 5. Moreover, Applicants point out that the Examiner, in paragraph 5, rejects independent claim 1 in view of Chen '755 and Lin '791 and then, in paragraph 6, rejects dependent claims 4-5, 8 and 10 in view of a further reference – Lin '094, without providing any discussion of the apparently newly introduced "Chen et al (U.S. Pat. No. 5,130,268)" primary reference. In view of the discrepancies of the previous Office action, Applicants believe that in paragraphs 6 and 7 of the subject Office action, the Examiner may have simply

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neglected to correct "Chen et al (U.S. Pat. No. 5,130,268)" to "Chen et al (U.S. Pat. No. 5,110,755)", as was done in paragraph 5.

Nonetheless, Applicants respectfully submit that independent claim 1 is distinguished from either Chen '755 or USPN 5,130,268 in view of Lin '791 because neither Chen '755 nor USPN 5,130,268 provides for forming a p⁺ layer surrounding a trench after a dielectric layer is formed on the surfaces of the trench and further because Lin '791 does not make up for these deficiencies.

Now, the reference of Lin '094 has apparently been relied upon for providing boron ion dosage parameters, particular oxide thicknesses and particular characteristics of the etching bath. Lin '094 therefore does not make up for the above-stated deficiencies of Chen '755 or USPN 5,130,268 in view of Lin '791. Therefore, independent claim 1 and dependent claims 4-5, 8 and 10 are distinguished from these references, taken alone or in combination. As such, the rejection of claims 4-5, 8 and 10 under 35 U.S.C. § 103(a) should be withdrawn.

V. Rejection of Claim 7 under 35 U.S.C. § 103

In paragraph 7 of the Office Action, claim 7 was rejected under 35 U.S.C. § 103(a) as being unpatentable over "Chen et al (US Pat. No 5,130,268)" in view of Lin '791 and in further in view of Wolf, Silicon Processing for the VLSI Era, Vol. I, pp. 156-157. Applicants respectfully submit that this claim rejection is overcome for reasons set forth below.

As discussed in section IV., above, Applicants believe the Examiner may be referring to Chen '755, not USPN 5,130,268.

Claim 7 is a dependent claim that depends from amended independent claim 1 which is distinguished from the references of Chen '755 (or USPN 5,130,268) in view of Lin '791 for reasons set forth above.

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5 The reference of Wolf has apparently been relied upon to establish that it is well known in the art to form an epitaxial silicon layer by MBE. Wolf therefore does not make up for the above-stated deficiencies of [Chen '755 or USPN 5,130,268] in view of Lin '791 and therefore claim 7 is distinguished from the references of Chen '755, USPN, 5,130,268, Lin '791, and Wolf, taken alone or in combination. As such, the rejection of claim 7 under 35 U.S.C. § 103(a) should be withdrawn.

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CONCLUSION

Based on the foregoing, each of pending claims 1-18 is in allowable form and the application in condition for allowance, which action is respectfully and expeditiously requested.

- 5 The Assistant Commissioner for Patents is hereby authorized to charge any additional fees or credit any excess payment that may be associated with this communication to Deposit Account 04-1679.

Respectfully submitted,

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